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Small System Corrections to Hydrodynamics

We show analytically that the small system corrections to thermodynamics quantities such as pressure and energy density are large, order 30%, for massless free scalar field theory in systems of size and temperature relevant for high-energy nuclear collisions. These analytic expectations are confirmed by quenched lattice QCD calculations of pressure and energy density in an anisotropic system and in the equation of state in a small system. We then lay the theoretical foundations for the analytic evaluation of the small system corrections to the NLO ϕ^4 theory equation of state: we introduce a new regularization scheme appropriate for systems without the symmetries necessary for dimensional regularization, and then apply this regularization scheme to determine the finite system size corrections to the running of the coupling. An estimate of the effect of small system corrections on the equation state are again large, order 50%. These small system corrections to thermodynamic quantities therefore must be taken into account when comparing hydrodynamics calculations to collective observables in small systems such as central pA and high-multiplicity pp collisions.

Category

Theory

Collaboration (if applicable)

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